INBLAST--A New and Revised Computer Code for the Prediction of Blast Inside Closed or Vented Structures

prepared by

Paul E. Montanaro
and
Michael M. Swisdak, Jr.
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

ABSTRACT

The computer code INBLAS was developed and published in the early 1970's to describe the blast produced by the reaction of energetic materials inside closed or partially vented structures. Since that time, refinements have been made to several of the code algorithms. These changes have been collected into a new version of the code called INBLAST. This version is designed to run on a desk top personal computer. The code is briefly described. Sample problems are presented and some of the results are compared with experimental data.

BACKGROUND

In 1972, Proctor[1] published the first version of a computer code designed to describe the phenomena associated energetic reactions inside closed structures. Since that original publication, many of the basic algorithms and concepts contained within the code have been improved and/or expanded and have become widely used in later versions of the same code or incorporated into other codes. In 1976, Ward and Lorenz of the Naval Surface Weapons Center (NSWC) developed a module for the program that allowed the use of time-dependent burning of the energetic material (rather than detonation). Other sections have become obsolete or superceded as new technology or information has become available. The best example of the latter are the sections of the code dealing with shock wave reflections within the chamber and the accompanying loading on the chamber walls. Waterways Experiment Station (WES) and their contractor Applied Research Associates (ARA) replaced the original shock calculations in INBLAS with more accurate shock reflection and superposition algorithms to form the BLASTINW code in the early 1980's[2,3,4].

The original code was designed and written to run on a main-frame computer. With the proliferation of both versions of the computer code and of desk top computers, the Department of Defense Explosives Safety Board (DDESB) deemed desirable to both update the original code and to produce a version which would run on a personal computer. This

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
AUG 1990		**00-00-1990 to 00-00-1990**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
INBLAST - A New and Revised Computer Code for the Prediction of Blast Inside Closed or Vented Structures	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Surface Warfare Center,10901 New Hampshire Avenue,Silver Spring,MD,20903-5000**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADA235005, Volume 1. Minutes of the Explosives Safety Seminar (24th) Held in St. Louis, MO on 28-30 August 1990.

14. ABSTRACT
see report

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**37**	

updated code could be compared with experimental data and then become a benchmark against which future versions or variations of the code could be compared.

In order to accomplish this task, it was felt that the "best parts" of both the INBLAS code and the BLASTINW code should be combined and a new and improved code produced. This effort was undertaken by the Boeing Military Airplane Company (Mr. Richard Lorenz) under contract to the Naval Surface Warfare Center (NAVSWC). This task was accomplished in 1989. At that time, however, it was felt that the program was still not "user friendly". NAVSWC then began the task of developing an input module which, through a series of interactive screens, generates, runs, and displays the output of the INBLAST program.

The remainder of this paper is a brief description of the basic program as well as a discussion of the interactive screens and the solution of two sample problems. It should be noted that this paper is not designed as a tutorial on the structure and uses of INBLAST. Rather the paper describes the program in general, with emphasis on the recent changes and improvements.

DESCRIPTION OF THE CONFINED EXPLOSION GAS PRESSURE CALCULATION

The chemical reaction of the explosion/burning and mixing with air in a closed structure creates the combustion products Al_2O_3, H_2O, CO, CO_2, C, Al, H_2, O_2, and N_2. A priority in the reaction is assumed as follows: (1) The aluminum in the energetic material reacts with oxygen to form the solid Al_2O_3; if there is insufficient oxygen, the remaining Al is treated as a solid. (2) The hydrogen has the next priority on the oxygen to form H_2O; again for insufficient oxygen, the remaining hydrogen is treated as H_2. (3) If there is an overabundance of oxygen in the energetic material and structure atmosphere, complete combustion occurs such that all carbon appears as CO_2 and the remaining oxygen not needed in any of the reactions appears as O_2. (4) If there is insufficient oxygen in the system after the Al_2O_3 and H_2O reactions, then CO and CO_2 are produced in quantities given by the the following equations:

$$n(C) + m(O) \Rightarrow a(CO) + b(CO_2) \qquad \text{for } m>n$$

$$a + b = n \qquad\qquad a = 2n - m$$

or

$$a + 2b = m \qquad\qquad b = m - n$$

where

a = number of moles of CO produced
b = number of moles of CO_2 produced
n = number of moles of C
m = number of remaining moles of O

and no O_2 exists in the final combustion products. (5) In the above equations, if m<n, no CO_2 will be formed or if b = 0, then CO is produced such that a=m and solid carbon particles will appear in the combustion products in the amount n-m. (6) The nitrogen does not participate in the reaction and appears as N_2 in the final mixture. From the above calculations, the number of moles of component gases and solids that make up the final products in the closed structure can be calculated. Once these are known, the final pressure and temperature within the chamber can be calculated.

The following information is required to perform an INBLAST quasi-static pressure calculation:

(1) C-H-N-O content of the energetic material
(2) Heat of formation of the energetic material
(3) Weight of energetic material.
(4) Volume of initial chamber
(5) Vent area of exit from initial chamber
(6) Volume of secondary chamber
(7) Vent area of exit from secondary chamber
(8) Ambient pressure and temperature.

The program allows for multiple chambers with energetic events possible in any of them. Each chamber may be vented to any other chamber or to an ambient reservoir. The equations governing the flow between the chambers are the appropriate ones for both supersonic and subsonic flow through a perfect nozzle. The ratio of the specific heats, γ, is not taken as a constant of 1.4--rather it is allowed to assume an appropriate value determined by the pressure, volume, temperature and mix of constituents of the gases exiting the chamber.

COMPUTATIONAL RANGE

The original version of the program (INBLAS) was demonstrated to accurately predict the confined gas pressures as a function of loading density (charge weight divided by chamber volume) over several orders of magnitude in pressure. This has not changed. In fact, the range has been extended even further. This comparison is shown in Figure 1. The computation is for TNT and was performed with this latest version of the code.

DESCRIPTION OF THE SHOCK CALCULATION

The program utilizes techniques and algorithms developed for the LAMB (Low Altitude Multi-Burst) computer code to predict the direct and multiply reflected shockwaves present after a detonation inside a closed chamber. For a description of these techniques, the reader is referred to References 2 and 3.

HARDWARE REQUIREMENTS

The program is designed to run on any IBM-compatible machine using DOS 3.1 operating system (or higher) with 640 kilobytes of memory and a hard disk. The program supports CGA, EGA, and VGA color monitors. An IBM-AT (or faster) machine with math co-processor is required.

GENERAL

Before running INBLAST copy all files from the INBLAST floppy disk to a directory on your hard disk. The file INBLAST2.EXE is the INBLAST program. It is written in FORTRAN 77 and performs all of the internal blast calculations. It reads all of its input data from the file INBLAST.IN. MENU.EXE is an interactive screen input program, which is written in BASIC. It reads the file INBLAST.IN, allows easy modification and then rewrites INBLAST.IN. The file GO.EXE controls both INBLAST2.EXE and MENU.EXE allowing them to be run as one unit.

To run INBLAST type **GO** from inside the directory which contains the INBLAST files. A message will appear asking you whether you want to use the values from the previous run, or use all default values. Using the previous values will cause the program to read the file INBLAST.IN, which contains input information used for the last run of INBLAST. Using the default values will reset all input values to their default.

The input to the program is prepared interactively through a series of screens which question the user. The are a total of twelve input screens; however, depending on the type of calculation being performed, not all of them will be used or seen by the user. Also some screens are used several times to allow for input of multiple energetic materials. The number of each input screen and its description are shown at the top of each screen. Notes are often shown at the bottom of the screen in red. Brief descriptions of each input item are shown in yellow. Items in brown cannot be changed. They either do not apply for the particular type of calculation or they are automatically set to a default value. Units for the inputs and their minimum and maximum values, are shown in green. The effect of function keys are shown in blue at the bottom of each input screen. Pressing F1 will set a number to its default value. F2 moves you to the next screen. F3 takes you back to the main menu.

When an input screen is shown, you may change any value by over-typing it and then pressing "Enter". You must press "Enter" here; pressing F2 will take you to the next screen but does not enter the new value. If a value does not need to be changed, just press "Enter". This will move you to the next input. If all items on the screen are correct, press F2. Continue doing this until you have gone through all of the input screens, and have returned to the main menu.

DESCRIPTION OF INPUT SCREENS

MAIN MENU

See Figure 3. Upon entering the program, you will see the Main Menu. Item 1 should always be selected before running INBLAST. It allows you to modify the input conditions for INBLAST. Select item 1 by typing a 1 and pressing the "Enter" key ("Return" key on some keyboards). Item 2 runs the INBLAST program after input is completed. Item 3 displays the program output on the screen or printer. Item 4 exits the program, returning you to DOS.

Let us assume that item 1 was initially selected.

INPUT SCREEN 1 - GENERAL OPTIONS

See Figure 4. This first item is the title of the run. This can be up to 80 characters long. It will be printed at the top of the program output.

The second and most important item is the type of calculation. Select number 1 for shock loading in a closed room. This option calculates direct and multiply-reflected shocks in a single closed chamber. However multiple chambers and multiple energetic materials can be specified if you wish to do many different closed chamber calculations at one time. Option 2 is for shock and combustion. This is similar to option 1 but also performs instantaneous combustion and calculates the confined explosion gas pressure (quasi-static pressure). Option 3 is for shock, combustion, and venting. This is similar to option 2 but also performs venting calculations into multiple chambers. Option 4 is instantaneous combustion. It reacts energetic materials instantaneously and determines quasi-static pressure. Option 5 is combustion and venting. Time dependent burning is allowed only here. Energetic materials can time dependently react and their gases vent into other chambers.

The third and fourth items are self explanatory. You can have up to 20 energetic materials and chambers.

The last item is the number of targets in confined shock calculations. This only applies for calculation options 1, 2, and 3, where shocks are calculated. A target is a location in a chamber where the shock is calculated. You can have up to 20 targets.

INPUT SCREEN 2 - GENERAL OPTIONS CONTINUED

See Figure 5. Enter the maximum time to be calculated. INBLAST will stop its calculations after this period of time. If zero is entered, the program selects a maximum computational time.

Select the default type of calculation appropriate to this run. Gas pressure refers to quasi-static pressure.

The maximum order of reflected rays is the maximum number of shock reflections calculated.

The run identification name is used for generating plot files. A plot file is an ASCII file generated by the program containing a table of time vs. pressure and impulse.

INPUT SCREEN 3 - EXPLOSIVE DATA

See Figure 6. At the top of the screen the program tells you the number of the energetic material you are inputting. For each energetic material, this screen will be duplicated. For each energetic material, select whether it will be a single energetic material from the table (see Table 1, Table of Energetic Materials), or a mixture of energetic materials from the table, or a material not in the table, or a gaseous material not in the table.

For a single material you will have to select the material from the list and then go on to the next screen. For a mixture of materials, you will select each one and type in their weight fraction in the mixture. The total weight fraction should add up to 1 (if the weight fraction does not add up to 1, the program adjusts the values until they do). Also enter the equivalent weight of the mixture. If zero is entered, then a weighted average of the equivalent weights of the mixed components is used. For a material not in the table you must enter its name, equivalent weight, energy of formation, and a table of material components vs. weight fraction respectively. For a gaseous explosive, the molar fraction of the explosive in the chamber and the molecular weight of the explosive must also be entered. A gaseous explosive cannot be used for shock calculations.

INPUT SCREEN 4 - EXPLOSIVE DATA CONTINUED

See Figure 7. This screen must be input for each energetic material. Enter the weight of the material, and the chamber in which it will burn or detonate.

For shock calculations, enter the X, Y, and Z coordinates of the explosion. These numbers must be less than the dimensions of the chamber.

Enter the minimum chamber temperature required to initiate the explosive. If this is zero, the explosive initiates immediately. Also you can enter the time required to initiate the explosive at that temperature.

For time dependent burning, enter the initial weight of the energetic material burned. This amount will be burned in the first step of the reaction. If this is zero, then it will be set to the weight of the material divided by 1000.

If the material undergoes time dependent burning answer **Y** to the question, otherwise answer **N**.

INPUT SCREEN 5 - 1ST BURN TABLE

See Figure 23. This screen will only appear if an energetic material undergoes time dependent burning, and must be input separately for each of these materials. Enter a table of burn area vs. weight burned. Up to 50 pairs can be entered in this table. To calculate numbers for the table use the following procedure:

CONSIDER FIRST, A SINGLE PROPELLANT GRAIN AS SHOWN IN FIGURE 2.

It is assumed that the energetic material (grain) is a cylindrical solid with multiple cylindrical perforations.

STEP 1: Calculate total surface area and volume of unreacted grain

R_0	Radius of grain (in)
R_i	Radius of perforation (in)
L	Length of Grain (in)
n	Number of perforations
Δx	Small increment change in dimension (in)
r	density of grain (lbs/in^3)
W	weight of propellant (lbs)

Initial Area: $(2*\pi*R_0*L) + n*(2*\pi*R_i*L) + 2*(\pi*R_0^2 - n*\pi*R_i^2)$

Initial volume $(\pi*R_0^2 - n*\pi*R_i^2)*L$

STEP 2 Change dimensions by Δx

R_0 becomes $R_0-\Delta x$
R_i becomes $R_i+\Delta x$
L becomes $L-2*\Delta x$

STEP 3 Calculate new Surface Area and new volume and new weight (density * volume)

STEP 4 Repeat Steps 2 & 3

Continue until either:

$R_0-\Delta x$ becomes 0
$L-2*\Delta x$ becomes 0
$\pi*(R_0-\Delta x)^2 - n*\pi*(R_i+\Delta x)^2$ becomes 0

NOTE Δx should be chosen such that the change in area/volume is adequately described

STEP 5 Generate a table consisting of pair of numbers (total burn area, weight burned). This table can contain up to fifty pairs (Note: the first pair must be (initial surface area, 0) and final pair must be (0, weight of grain))

STEP 6 Calculate total number of grains (total weight/weight of one grain)

STEP 7 Multiply each entry in table generated in STEP 5 by the total number of grains--this will give a burn area vs. weight burned table

INPUT SCREEN 6 - 2ND BURN TABLE

See Figure 24. Again, this screen will only appear if an energetic material undergoes time dependent burning, and must be input separately for each of these materials. Enter a table of burn rate times explosive density vs. pressure. Up to 20 pairs can be entered in this table. To calculate numbers for the table use the following procedure:

Determine rate equation for material: must be of form--

$r = a*P^n$ where

r	rate in in/sec
a,n	coefficients of rate equation chosen to give proper units for r
ρ	Propellant density

Estimate highest expected pressure to be produced during burning--

Generate a table of (burn rate * explosive density ($r*\rho$) vs. pressure)--note: first entry must be for 0 pressure--last entry should be for a pressure 5*highest expected

INPUT SCREEN 7 - AMBIENT CONDITIONS

See Figure 8. Enter the default pressure and temperature for the ambient chamber (the atmosphere). If zero is entered, the 1959 ARDC standard atmosphere is used for pressure and temperature.

Enter the altitude above sea level to be used in the calculations.

Enter the default initial pressure, temperature, and mole (volume) fraction of oxygen (O_2) in the chambers. If zero is entered for the pressure and temperature, the ambient pressure and temperature will be used. The mole fraction of oxygen must be > 0 and ≤ 1. The remainder is nitrogen.

INPUT SCREEN 8 - CHAMBER DATA

See Figure 9. The first line input here is the default for all of the chambers. If you have more than one chamber, you can override this default for each individual chamber as needed, starting with chamber 2. Enter the chamber volume, the dimensions of the chamber, and whether a plot file of time vs. pressure and impulse is desired. Make sure that the chamber dimensions are compatible with the chamber volume. If the volume is set to zero, the volume will be calculated from the dimensions of the chamber. An ambient chamber (the atmosphere) is defined by setting the volume to less than zero.

INPUT SCREEN 9 - CHAMBER DATA CONTINUED

See Figure 10. This is a continuation of the previous screen. For each chamber shown, enter the print option, the type of calculation, the initial pressure and temperature, and the mole (volume) fraction of oxygen. A print option of zero will print only peaks. A one will print P(t) and I(t). Enter the appropriate type of calculation from the options shown at the bottom of the screen. Enter zero to use the default initial pressure, temperature, and mole fraction of oxygen, which were already specified on input screen 7.

INPUT SCREEN 10 - VENTING DATA

See Figure 28. Enter the number of vent paths connecting the chambers. Vents can be permanent or can form after a wall fails.

The number of venting cycles is the total number of venting calculations made during the INBLAST run. The higher this number, the more accurate the answers will be, however, the run will also take longer. When using a high number of venting cycles, the program output becomes too long. For this reason, you can choose the number of venting cycles to be calculated between printouts.

Enter a constant time step to be used between venting calculations. If zero is entered, the program uses a variable time step.

INPUT SCREEN 11 - VENT FAILURE DATA

See Figure 29. In this screen, you specify which two chambers are connected by each vent, the minimum pressure differential for wall failure to occur, and the minimum time at this pressure difference for wall failure. A secondary failure is where a vent between chambers becomes enlarged at a later time due to a larger area of the wall failing.

INPUT SCREEN 12 - TARGET DATA

See Figure 11. In this screen you enter the chamber where each target is located, and its coordinates.

SAMPLE CALCULATIONS

Let us consider two problems. Each will be described. Samples of the input screens and the output will be presented.

PROBLEM 1 (Figures 4 - 12)

Eighteen pounds of Composition C-4 are detonated inside a closed chamber. The chamber has dimensions 10 ft. by 10 ft. by 10 ft. The explosive is located in the center of the chamber. The target is located at coordinates (5, 0, 5) within the chamber). Calculate the direct and reflected shock wave parameters at the target for this event.

PROBLEM 2 (Figures 13 - 30)

This problem illustrates multiple explosions in multiple chambers. One charge detonates in Chamber 1. Two charges, one delayed, detonate in Chamber 8. Gases vent between chambers as walls fail, and finally into Chamber 7 which vents to the ambient atmosphere (Chamber 9). Time-dependent burning takes place in Chamber 2, which is isolated from the others. Final conditions should compare with the initial conditions, following the explosion in Chamber 1. Note that the slow burning in Chamber 2 uses up all of the oxygen before all of the carbon can react.

There are four energetic materials and nine chambers. A 200 pound charge of Pentolite detonates in Chamber 1. A 200 pound charge of Pentolite undergoes time-dependent burning in Chamber 2. In Chamber 8, 150 pounds of HMX detonate. Also in Chamber 8, there are 150 pounds of OCTOL which detonate when the Chamber temperature reaches 800°R for 0.02 seconds.

All chambers have a volume of 1000 ft^3, with the exception of Chamber 9, which is an ambient reservoir.

There are 10 vents multiply connecting the chambers.

REFERENCES

1. Proctor, James F., "Internal Blast Damage Mechanisms Computer Program," NOL TR 72-231, 31 August 1972.

2. Britt, J.R. et. al., "BLASTINW User's Manual," ARA 5986-2, Applied Research Associates, Inc., Vicksburg, MS, April 1986.

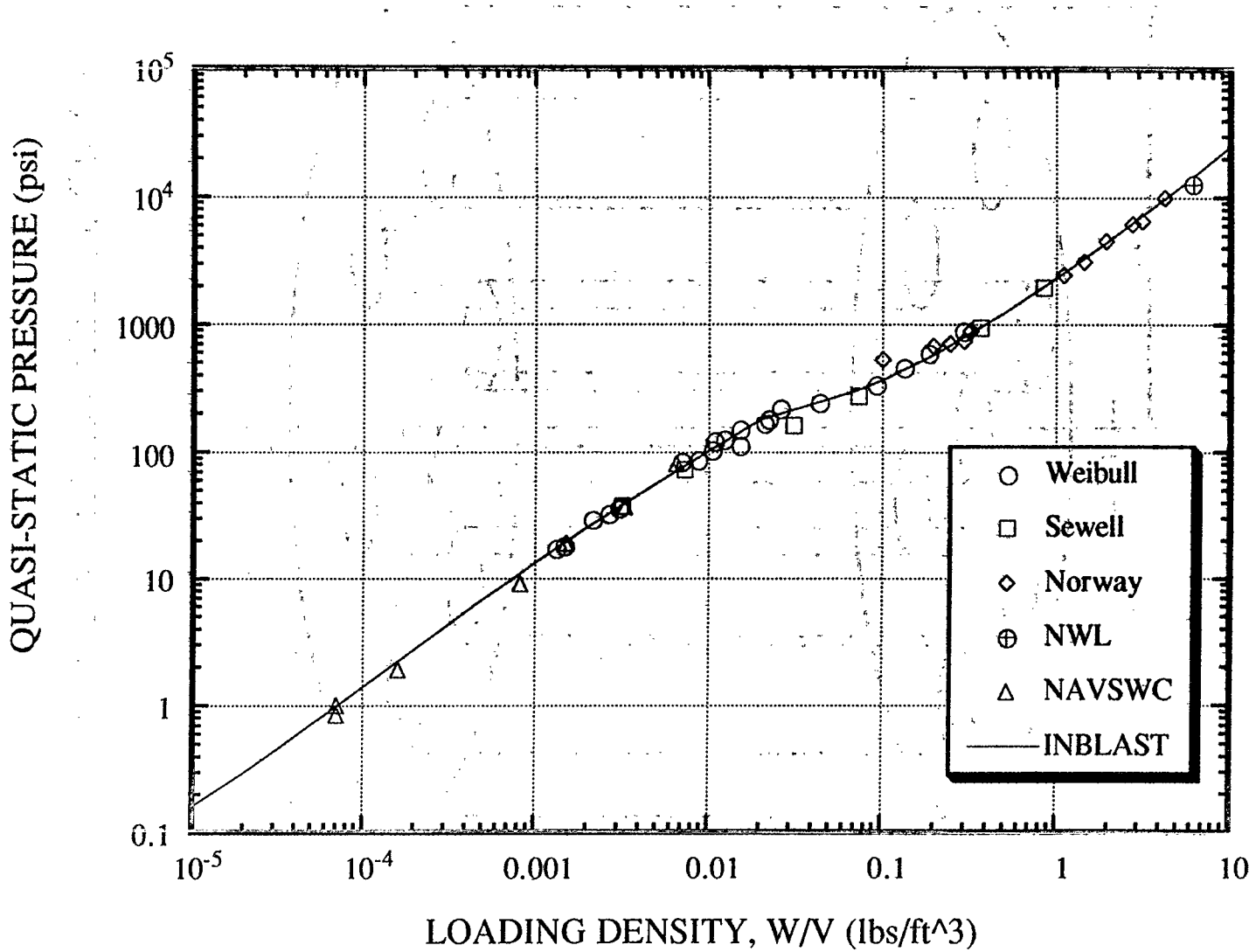
3. Britt, J. R. and Drake, J. L., "Blast Loads from Internal Explosions and Other Reflected Shock Waves," International Symposium on the Interaction of Conventional Munitions with Protective Structures, 9-13 March 1987.

4. Nelson, D. H. and Watt, J. M., "Analysis of Internal Blast Loads in Vented Chambers," Minutes of the Twenty-Third Explosives Safety Seminar, Volume II, 9-11 August 1988.

TABLE 1 TABLE OF EXPLOSIVES

NUMBER	NAME	EQWT	EFORM	C	H	N	O	Al
1	TNT	1.00	-70.50	0.3702	0.0222	0.1850	0.4227	0.0000
2	TNETB	1.13	-307.10	0.1860	0.0170	0.2170	0.5800	0.0000
3	EXPLOSIVE D	0.85	-382.00	0.2926	0.0246	0.2276	0.4551	0.0000
4	PENTOLITE (50/50 PETN/TNT)	1.40	-237.10	0.2798	0.0239	0.1807	0.5155	0.0000
5	PICRATOL (52/48 EXPL D/TNT)	0.90	-238.50	0.3290	0.0240	0.2070	0.4400	0.0000
6	CYCLOTOL (70/30)	1.14	26.22	0.2254	0.0257	0.3193	0.4294	0.0000
7	COMPOSITION B	1.10	11.48	0.2513	0.0264	0.2983	0.4241	0.0000
8	RDX/WAX (98/2)	1.19	57.00	0.1760	0.0300	0.3710	0.4230	0.0000
9	COMPOSITION A-3	1.09	28.40	0.2233	0.0375	0.3428	0.3964	0.0000
10	TNETB/Al (90/10)	1.23	-276.40	0.1680	0.0140	0.1960	0.5220	0.1000
11	TNETB/Al (78/22)	1.18	-239.50	0.1460	0.0120	0.1700	0.4520	0.2200
12	TNETB/Al (72/28)	1.18	-221.10	0.1340	0.0110	0.1570	0.4180	0.2800
13	TNETB/Al (65/35)	1.23	-199.60	0.1210	0.0100	0.1420	0.3770	0.3500
14	TRITONAL (TNT/Al 80/20)	1.07	-53.68	0.2960	0.0178	0.1480	0.3382	0.2000
15	RDX/Al/WAX (88/10/2)	1.30	50.38	0.1600	0.0270	0.3330	0.3800	0.1000
16	RDX/Al/WAX (78/20/2)	1.32	43.76	0.1440	0.0240	0.2950	0.3370	0.2000
17	RDX/Al/WAX (74/21/5)	1.30	29.36	0.1630	0.0270	0.2800	0.3200	0.2100
18	RDX/Al/WAX (74/22/4)	1.30	33.28	0.1540	0.0260	0.2800	0.3200	0.2200
19	RDX/Al/WAX (62/33/5)	1.19	21.42	0.1430	0.0240	0.2350	0.2680	0.3300
20	TORPEX II (42/40/18 RDX/TNT/Al)	1.24	-3.57	0.2161	0.0203	0.2328	0.3507	0.1800
21	H-6	1.38	-17.48	0.2230	0.0259	0.2238	0.3171	0.2100
22	HBX-1	1.17	-25.40	0.2482	0.0265	0.2216	0.3336	0.1700
23	HBX-3	1.14	-25.30	0.2003	0.0221	0.1709	0.2566	0.3500
24	TNETB/RDX/Al (39/26/35)	1.24	-102.60	0.1150	0.0130	0.1840	0.3380	0.3500
25	ALUMINUM	0.00	0.00					1.0000
26	WAX	0.00	-392.00	0.8560	0.1440	0.0000	0.0000	0.0000
27	RDX	1.10	66.16	0.1621	0.0272	0.3782	0.4322	0.0000
28	PETN	1.27	-407.10	0.1898	0.0255	0.1772	0.6074	0.0000
29	TETRYL	1.07	16.26	0.2928	0.0176	0.2439	0.4458	0.0000
30	HMX	1.10	61.00	0.1621	0.0272	0.3782	0.4322	0.0000
31	OCTOL (HMX/TNT 75/25)	1.10	28.62	0.2135	0.0260	0.3303	0.4302	0.0000
32	PBXW-9 (estimated)	1.30	72.40	0.2050	0.0340	0.3480	0.4130	0.0000
33	MOTOR OIL	0.00	-400.00	0.8470	0.1410	0.0000	0.0000	0.0000
34	POLYISOBUTYLENE	0.00	-840.00	0.8600	0.1400	0.0000	0.0000	0.0000
35	DI-SEBACATE	0.00	-780.00	0.7300	0.1200			
36	AMMONIUM NITRATE (AN)	0.70	-1084.00	0.0000	0.0504	0.3497	0.5998	0.0000
37	IREMITE-60	1.00	-999.50	0.0000	0.0462	0.3029	0.5499	0.0330
38	NITROMETHANE	1.00	-442.00	0.1966	0.0495	0.2295	0.5244	0.0000
39	PBX-9404	1.20	0.80	0.1705	0.0281	0.3650	0.4364	0.0000
40	POLYSTYRENE	0.00	181.70	0.9226	0.0774	0.0000	0.0000	0.0000
41	WATER	0.00	-3792.00	0.0000	0.1119	0.0000	0.8881	0.0000
42	ANFO (94/6 AN/FO)	0.87	-1043.40	0.0515	0.0558	0.3289	0.5638	0.0000
43	COMPOSITION C-4	1.40	32.43	0.2185	0.0357	0.3444	0.4014	0.0000
44	NITROCELLULOSE (NC)(12%N)	0.50	-658.00	0.2646	0.0278	0.1260	0.5816	0.0000
45	NITROCELLULOSE (NC)(13.35%N)	0.50	-574.00	0.2529	0.0252	0.1345	0.5874	0.0000
46	NITROCELLULOSE (NC)(14.14%N)	0.50	-525.00	0.2425	0.0237	0.1414	0.5924	0.0000
47	NITROGYLCERINE (NG)	1.80	-390.00	0.1585	0.0222	0.1850	0.6343	0.0000
48	TATB (Triaminitrinitrobenzene)	1.00	-142.70	0.2790	0.0234	0.3255	0.3720	0.0000
49	CYCLOTOL (75/25)	1.14	32.89	0.2141	0.0260	0.3299	0.4300	0.0000
50	M1 PROPELLANT	1.00	-539.00	0.3039	0.0309	0.1265	0.5387	0.0000
51	LX-14	1.80	15.00	0.1824	0.0294	0.3626	0.4256	0.0000
52	NITROGUANIDINE (NQ)	1.00	-212.00	0.1154	0.0387	0.5383	0.3076	0.0000
53	FUEL OIL (FO)	0.00	-406.70	0.8591	0.1409	0.0000	0.0000	0.0000

FIGURE 1 COMPARISON OF MEASURED QUASI-STATIC PRESSURE WITH INBLAST COMPUTATIONS



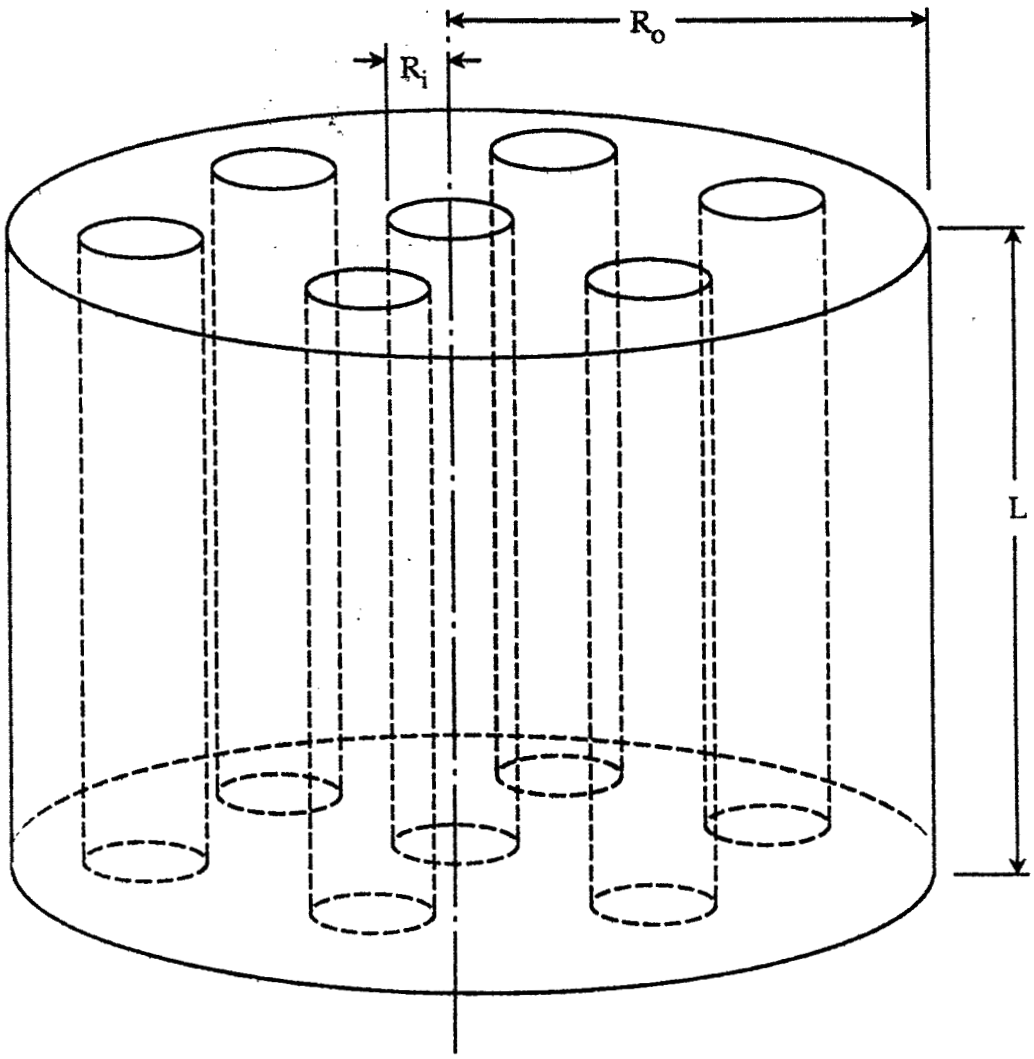


FIGURE 2 SCHEMATIC OF GRAIN

Figure 3: MAIN MENU

```
                INBLAST PROGRAM
                 (MAIN MENU)

          1.  CHANGE INPUT CONDITIONS

          2.  RUN INBLAST PROGRAM

          3.  DISPLAY OUTPUT FILE

          4.  EXIT PROGRAM

      ENTER SELECTION NUMBER AND PRESS ENTER
```

Figure 4: INPUT SCREEN 1 - PROBLEM 1

```
                              INBLAST PROGRAM
                        (Input Screen 1 / GENERAL OPTIONS)

Title of Run
TEST1.....SHOCK LOADING in a closed chamber

Select Type of Calculation  1

  1. SHOCK loading in a closed room
  2. SHOCK and COMBUSTION
  3. SHOCK and COMBUSTION and VENTING
  4. INSTANTANEOUS COMBUSTION
  5. COMBUSTION and VENTING (time dependent burning)


Number of Sources of Energetic Materials (1 - 20)  1

Number of Chambers (1 - 20)  1

Number of Targets in Confined Shock Calcs (1 - 20)  1


F1 SET TO      F2 GOTO NEXT    F3 GOTO        NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT        SCREEN          MAIN MENU         UNTIL RETURN KEY IS PRESSED
```

Figure 5: INPUT SCREEN 2 - PROBLEM 1

```
                        INBLAST PROGRAM
                (Input Screen 2 / GENERAL OPTIONS cont.)

Maximum Time to be Calculated (sec)  15
(If ZERO, time is unlimited and a maximum
time is calculated for confined shocks)

Default Type of Calculation  2

  0. Shock & Gas & Venting
  1. Gas Pressure Only
  2. Shock Pressure Only
  3. Shock & Gas, and Average Target

Maximum order of reflected rays to be
used in the confined shock calculations  6

RUN IDENTIFICATION NAME
(used for PLOT FILE NAMES)  TEST1



F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 6: INPUT SCREEN 3 - PROBLEM 1

```
ENERGETIC SOURCE #1          INBLAST PROGRAM
                    (Input Screen 3,1 / EXPLOSIVE DATA)
ENTER SELECTION  1

1. One Energetic Material from Table
2. Mixture of Energetic Materials from Table
3. Energetic Material not in Table
4. Gaseous Energetic Material not in Table

Name of Energetic Materials Used        Weight Fraction of Material in Mixture
COMP C-4                                1



Note: If total weight fraction >1.0 then each is adjusted so the new total = 1.0
      If total weight fraction <1.0 then the remainder is assumed an INERT SOLID

F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 7: INPUT SCREEN 4 - PROBLEM 1

```
ENERGETIC SOURCE #1          INBLAST PROGRAM
                  (Input Screen 4,1 / EXPLOSIVE DATA cont.)

Weight of Energetic Material (lb)  18

Number of Chamber in Which Energetic Material will Burn or Detonate  1

X - Coordinate of Explosion (ft)  5

Y - Coordinate of Explosion (ft)  5

Z - Coordinate of Explosion (ft)  5

Minimum Chamber Temp. Required to Initiate Explosive (deg R)  0

Minimum Time at Temperature to Initiate Explosive (sec)  0

Initial Weight of Energetic Material Burned (lbs)  0
(If ZERO, Initial Weight is set to Weight of Energetic Material/1000)

Does This Energetic Material Undergo Time Dependent Burning (Y/N)  N

F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 8: INPUT SCREEN 7 - PROBLEM 1

```
                          INBLAST PROGRAM
                  (Input Screen 7 / AMBIENT CONDITIONS)

Default Pressure in Ambient Chamber (psia)  14.6959
(If ZERO, the 1959 ARDC standard atmosphere is used)

Default Temperature in Ambient Chamber (deg C)  15

Altitude Above Sea Level (kft)  0

Default Initial Pressure in Chambers (psia)  0
(If ZERO, the Ambient Pressure will be used)

Default Initial Temperature in Chambers (deg C)  0
(If ZERO, the Ambient Temperature will be used)

Default Mole (volume) Fraction of Oxygen (O2) in Chambers  .2095
(Fraction must be > 0 and <= 1, Remainder is Nitrogen (N2))

F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 9: INPUT SCREEN 8 - PROBLEM 1

INBLAST PROGRAM
(Input Screen 8 / CHAMBER DATA)

Chamber Number	Chamber Volume (cu ft)	Length X-Direction (ft)	Length Y-Direction (ft)	Length Z-Direction (ft)	Plot File (Y/N)
Default	1000	10	10	10	Y

Note: If Chamber Volume = 0, volume is set to XLEN * YLEN * ZLEN
Note: Chamber Dimensions are not checked for compatibility with Chamber Volume
Note: An Ambient Chamber is Defined by Setting Volume < 0

F1 SET TO DEFAULT F2 GOTO NEXT SCREEN F3 GOTO MAIN MENU NOTE: INDIVIDUAL DATA IS NOT SAVED UNTIL RETURN KEY IS PRESSED

Figure 10: INPUT SCREEN 9 - PROBLEM 1

INBLAST PROGRAM
(Input Screen 9 / CHAMBER DATA (Cont.)

Chamber Number	Print Option	Type Of Calculation	Init. Pres. In Chamber (0 for Default) (psia)	Init. Temp. In Chamber (0 for Default) (deg C)	Mole Fraction Of Oxygen (0 for Default) (0 - 1)
Default	1	2	0	0	0

Print Option 0 = Print only peaks 1 = Print P(T) & Impulse I(T)

Type of Calculation 0 = Shock & Gas & Venting 1 = Gas Pressure Only 2 = Shock Pressure Only 3 = Shock & Gas & Average Shock

F1 SET TO DEFAULT F2 GOTO NEXT SCREEN F3 GOTO MAIN MENU NOTE: INDIVIDUAL DATA IS NOT SAVED UNTIL RETURN KEY IS PRESSED

Figure 11: INPUT SCREEN 12 - PROBLEM 1

INBLAST PROGRAM
(Input Screen 12 / TARGET DATA)

Target Number	Chamber Where Target is Located	X-Coordinate of Target (ft)	Y-Coordinate of Target (ft)	Z-Coordinate of Target (ft)
1	1	5	0	5

F1 SET TO DEFAULT F2 GOTO NEXT SCREEN F3 GOTO MAIN MENU NOTE: INDIVIDUAL DATA IS NOT SAVED UNTIL RETURN KEY IS PRESSED

Figure 12: INBLAST OUTPUT - PROBLEM 1

```
INTERNAL BLAST DAMAGE MECHANISMS PROGRAM, JULY 1989

  TEST1.....SHOCK LOADING in a closed chamber

 NOPT= 1      NEXPL=   1      NCHAMS=   1      NTARGS=   1      NTITLE=   1

 TMAX(SEC)=  15.00        ICALCG=  2      MAXORD=   6      RUN ID=                    TEST1

 DEFINE EXPLOSIVE(S).....................................

  COMP C-4                              43
 EXPLOSIVE (  1) POSITION IN CHAMBER (  1):  X(FT)=  5.0000        Y(FT)=  5.0000        Z(FT)=  5.0000
 EXPLOSIVE (  1) PROPERTIES.....CHARGE WEIGHT(LB) =  18.00
 NUMBER EQWT   EFORM    EXPLOSIVE COMPOSITION BY WEIGHT
               KCAL/G     O2       N2       C        H2
   43  1.400   .032430    .4014    .3444    .2185    .0357

                          .....................EXPLOSIVE SUMMARY.....................
                         EXPLOSIVE    CHAMBER    TIME DELAY(SEC)    BURN TEMP(DEG R)
                            1            1         .0000               .0000

 PAMB(PSIA)=  14.70        TAMB(C)=  15.00        PCHAM(PSIA)=  14.70        TCHAM(C)=  15.00        FRAC O2=  .2095

 CHAMBER DATA.....NO. OF CHAMBERS =    1
   K0    VOL(CU FT)    P(PSIA)      TEMP(C)       GAS(LB)       GAMMA    FRAC-O2    ICALC   IPRINT   IPLOT   X(FT)         Y(FT)         Z(FT)
    1     1000.        14.70         15.00         76.18        1.3996    .2095       2        1        1      10.00         10.00         10.00



      BLAST - MULTIPLE EXPLOSIONS INSIDE A ROOM WITH VENTING BETWEEN ROOMS
          DATE                          ROOM NUMBER =  1

  TEST1.....SHOCK LOADING in a closed chamber

           TARGET LOCATION (FT)   NO.  1
 X =     5.000     Y =      .000     Z =     5.000

           PLOT FILE = TEST1T01


               CHARGE NUMBER   1
          CHARGE LOCATION (FT)
 X =     5.000     Y =     5.000      Z =     5.000
 CHARGE MASS (POUNDS) = 1.80000E+01       DETONATION DELAY (MSEC) = 0.00000E+00
      EXPLOSIVE COMPOSITION (DECIMAL FRACTION)
          COMP C-4                 1.00000
```

DIRECT PRESSURE (PSI) = 2.476E+02 ARRIVAL TIME (MSEC) = 6.410E-01

TOTAL VALUES

FIRST PRESSURE (PSI)	= 1.597E+03	TIME (MSEC) =	6.410E-01
PEAK PRESSURE (PSI)	= 1.597E+03	TIME (MSEC) =	6.410E-01
MINIMUM PRESSURE (PSI)	= -5.709E+00	TIME (MSEC) =	4.914E+00
PEAK IMPULSE (PSI*SEC)	= 1.391E+00	TIME (MSEC) =	1.307E+01

LAST TIME = 1.307E+01 PRESSURE = 4.159E+01 IMPULSE = 1.391E+00

NUMBER OF STEPS = 1000 MAXIMUM ORDER OF RAYS = 6

TIME (MSEC)	PRESSURE	IMPULSE
6.410E-01	0.000E+00	0.000E+00
6.410E-01	1.597E+03	0.000E+00
6.535E-01	1.463E+03	1.906E-02
6.659E-01	1.340E+03	3.651E-02
6.784E-01	1.227E+03	5.250E-02
6.908E-01	1.124E+03	6.715E-02
7.033E-01	1.031E+03	8.057E-02
7.157E-01	9.446E+02	9.287E-02
7.282E-01	8.661E+02	1.041E-01
7.406E-01	7.943E+02	1.145E-01
7.531E-01	7.286E+02	1.240E-01
7.656E-01	6.685E+02	1.327E-01
7.780E-01	6.135E+02	1.407E-01
7.905E-01	5.632E+02	1.480E-01
8.029E-01	5.172E+02	1.547E-01
8.154E-01	4.751E+02	1.609E-01
8.278E-01	4.365E+02	1.666E-01
8.403E-01	4.012E+02	1.718E-01
8.528E-01	3.689E+02	1.766E-01
8.652E-01	3.393E+02	1.810E-01
8.777E-01	3.122E+02	1.851E-01
8.901E-01	2.873E+02	1.888E-01
9.026E-01	2.645E+02	1.922E-01
9.150E-01	2.437E+02	1.954E-01
9.275E-01	2.245E+02	1.983E-01
9.400E-01	2.069E+02	2.010E-01
9.524E-01	1.908E+02	2.035E-01
9.649E-01	1.760E+02	2.058E-01
9.773E-01	1.625E+02	2.079E-01
9.898E-01	1.500E+02	2.098E-01
1.002E+00	1.385E+02	2.116E-01
1.015E+00	1.280E+02	2.133E-01
1.027E+00	1.183E+02	2.148E-01
1.040E+00	1.094E+02	2.162E-01
1.052E+00	1.013E+02	2.175E-01
1.065E+00	9.373E+01	2.188E-01
1.077E+00	8.680E+01	2.199E-01
1.089E+00	8.042E+01	2.209E-01
1.102E+00	7.454E+01	2.219E-01
1.114E+00	6.912E+01	2.228E-01
1.127E+00	6.412E+01	2.236E-01
1.139E+00	5.951E+01	2.244E-01
1.152E+00	5.526E+01	2.251E-01
1.164E+00	5.133E+01	2.258E-01

1.177E+00	4.771E+01	2.264E-01
1.189E+00	4.436E+01	2.269E-01
1.202E+00	4.126E+01	2.275E-01
1.214E+00	3.839E+01	2.280E-01
1.226E+00	3.574E+01	2.284E-01
1.239E+00	3.329E+01	2.289E-01
1.251E+00	3.114E+01	2.293E-01
1.264E+00	2.939E+01	2.296E-01
1.276E+00	2.774E+01	2.300E-01
1.289E+00	2.619E+01	2.303E-01
1.301E+00	2.471E+01	2.307E-01
1.314E+00	2.332E+01	2.310E-01
1.326E+00	2.201E+01	2.312E-01
1.339E+00	2.077E+01	2.315E-01
1.351E+00	1.960E+01	2.318E-01
1.363E+00	1.849E+01	2.320E-01
1.376E+00	1.744E+01	2.322E-01
1.388E+00	1.646E+01	2.324E-01
1.401E+00	1.552E+01	2.326E-01
1.413E+00	1.464E+01	2.328E-01
1.426E+00	1.381E+01	2.330E-01
1.438E+00	1.302E+01	2.332E-01
1.451E+00	1.228E+01	2.333E-01
1.463E+00	1.158E+01	2.335E-01
1.476E+00	1.092E+01	2.336E-01
1.488E+00	5.492E+02	2.371E-01
1.501E+00	5.388E+02	2.439E-01
1.513E+00	5.285E+02	2.505E-01
1.525E+00	5.184E+02	2.570E-01
1.538E+00	5.086E+02	2.634E-01
1.550E+00	4.989E+02	2.697E-01
1.563E+00	4.895E+02	2.759E-01
1.575E+00	4.802E+02	2.819E-01
1.588E+00	4.711E+02	2.878E-01
1.600E+00	4.622E+02	2.936E-01
1.613E+00	4.535E+02	2.993E-01
1.625E+00	4.449E+02	3.049E-01
1.638E+00	4.366E+02	3.104E-01
1.650E+00	4.284E+02	3.158E-01
1.662E+00	4.204E+02	3.211E-01
1.675E+00	4.126E+02	3.263E-01
1.687E+00	4.048E+02	3.314E-01
1.700E+00	3.973E+02	3.364E-01
1.712E+00	3.899E+02	3.413E-01
1.725E+00	3.826E+02	3.461E-01
1.737E+00	3.755E+02	3.508E-01
1.750E+00	3.685E+02	3.555E-01
1.762E+00	3.616E+02	3.600E-01
1.775E+00	3.550E+02	3.645E-01
1.787E+00	3.484E+02	3.688E-01
1.799E+00	3.419E+02	3.731E-01
1.812E+00	3.356E+02	3.774E-01
1.824E+00	3.294E+02	3.815E-01
1.837E+00	3.233E+02	3.856E-01
1.849E+00	3.174E+02	3.896E-01
1.862E+00	3.115E+02	3.935E-01
1.874E+00	3.058E+02	3.973E-01
1.887E+00	3.002E+02	4.011E-01
1.899E+00	2.946E+02	4.048E-01
1.912E+00	2.893E+02	4.084E-01

(860 lines removed)

1.262E+01	4.544E+01	1.378E+00
1.264E+01	4.447E+01	1.378E+00
1.265E+01	4.351E+01	1.379E+00
1.266E+01	4.255E+01	1.379E+00
1.267E+01	4.159E+01	1.380E+00
1.269E+01	4.064E+01	1.380E+00
1.270E+01	3.970E+01	1.381E+00
1.271E+01	3.877E+01	1.381E+00
1.272E+01	3.783E+01	1.382E+00
1.274E+01	3.690E+01	1.382E+00
1.275E+01	3.598E+01	1.383E+00
1.276E+01	3.507E+01	1.383E+00
1.277E+01	3.416E+01	1.384E+00
1.279E+01	3.325E+01	1.384E+00
1.280E+01	3.235E+01	1.384E+00
1.281E+01	3.146E+01	1.385E+00
1.282E+01	3.057E+01	1.385E+00
1.284E+01	2.968E+01	1.386E+00
1.285E+01	2.880E+01	1.386E+00
1.286E+01	2.792E+01	1.386E+00
1.287E+01	2.705E+01	1.387E+00
1.289E+01	2.619E+01	1.387E+00
1.290E+01	2.533E+01	1.387E+00
1.291E+01	2.447E+01	1.388E+00
1.292E+01	2.362E+01	1.388E+00
1.294E+01	2.277E+01	1.388E+00
1.295E+01	2.193E+01	1.388E+00
1.296E+01	2.110E+01	1.389E+00
1.297E+01	2.027E+01	1.389E+00
1.299E+01	1.944E+01	1.389E+00
1.300E+01	1.862E+01	1.389E+00
1.301E+01	1.780E+01	1.390E+00
1.302E+01	1.699E+01	1.390E+00
1.304E+01	1.618E+01	1.390E+00
1.305E+01	1.538E+01	1.390E+00
1.306E+01	1.457E+01	1.390E+00
1.307E+01	4.159E+01	1.391E+00

Figure 13: INPUT SCREEN 1 - PROBLEM 2

```
                    INBLAST PROGRAM
              (Input Screen 1 / GENERAL OPTIONS)

Title of Run
TEST5.....COMBUSTION and VENTING - multiple explosions in multiple chambers

Select Type of Calculation  5

  1. SHOCK loading in a closed room
  2. SHOCK and COMBUSTION
  3. SHOCK and COMBUSTION and VENTING
  4. INSTANTANEOUS COMBUSTION
  5. COMBUSTION and VENTING (time dependent burning)


Number of Sources of Energetic Materials (1 - 20)  4

Number of Chambers (1 - 20)  9

Number of Targets in Confined Shock Calcs (0 - 20)  0


F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 14: INPUT SCREEN 2 - PROBLEM 2

```
                    INBLAST PROGRAM
              (Input Screen 2 / GENERAL OPTIONS cont.)

Maximum Time to be Calculated (sec)  0
(If ZERO, time is unlimited and a maximum
time is calculated for confined shocks)

Default Type of Calculation  2

  0. Shock & Gas & Venting
  1. Gas Pressure Only
  2. Shock Pressure Only
  3. Shock & Gas, and Average Target

Maximum order of reflected rays to be
used in the confined shock calculations  0

RUN IDENTIFICATION NAME
(used for PLOT FILE NAMES)  TEST5


F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 15: INPUT SCREEN 3,1 - PROBLEM 2

```
ENERGETIC SOURCE #1          INBLAST PROGRAM
                  (Input Screen 3,1 / EXPLOSIVE DATA)
ENTER SELECTION  1

1. One Energetic Material from Table
2. Mixture of Energetic Materials from Table
3. Energetic Material not in Table
4. Gaseous Energetic Material not in Table

Name of Energetic Materials Used        Weight Fraction of Material in Mixture
PENTOLITE (PETN/TNT,50/50)              1

Note: If total weight fraction >1.0 then each is adjusted so the new total = 1.0
      If total weight fraction <1.0 then the remainder is assumed an INERT SOLID

F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 16: INPUT SCREEN 3,2 - PROBLEM 2

```
ENERGETIC SOURCE #2          INBLAST PROGRAM
                  (Input Screen 3,2 / EXPLOSIVE DATA)
ENTER SELECTION  1

1. One Energetic Material from Table
2. Mixture of Energetic Materials from Table
3. Energetic Material not in Table
4. Gaseous Energetic Material not in Table

Name of Energetic Materials Used        Weight Fraction of Material in Mixture
PENTOLITE (PETN/TNT,50/50)              1

Note: If total weight fraction >1.0 then each is adjusted so the new total = 1.0
      If total weight fraction <1.0 then the remainder is assumed an INERT SOLID

F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 17: INPUT SCREEN 3,3 - PROBLEM 2

```
ENERGETIC SOURCE #3          INBLAST PROGRAM
                  (Input Screen 3,3 / EXPLOSIVE DATA)
ENTER SELECTION  1

1. One Energetic Material from Table
2. Mixture of Energetic Materials from Table
3. Energetic Material not in Table
4. Gaseous Energetic Material not in Table

Name of Energetic Materials Used        Weight Fraction of Material in Mixture
HMX                                     1



Note: If total weight fraction >1.0 then each is adjusted so the new total = 1.0
      If total weight fraction <1.0 then the remainder is assumed an INERT SOLID

F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 18: INPUT SCREEN 3,4 - PROBLEM 2

```
ENERGETIC SOURCE #4          INBLAST PROGRAM
                  (Input Screen 3,4 / EXPLOSIVE DATA)
ENTER SELECTION  1

1. One Energetic Material from Table
2. Mixture of Energetic Materials from Table
3. Energetic Material not in Table
4. Gaseous Energetic Material not in Table

Name of Energetic Materials Used        Weight Fraction of Material in Mixture
OCTOL                                   1



Note: If total weight fraction >1.0 then each is adjusted so the new total = 1.0
      If total weight fraction <1.0 then the remainder is assumed an INERT SOLID

F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 19: INPUT SCREEN 4,1 - PROBLEM 2

```
ENERGETIC SOURCE #1          INBLAST PROGRAM
                  (Input Screen 4,1 / EXPLOSIVE DATA cont.)

Weight of Energetic Material (lb)  200

Number of Chamber in Which Energetic Material will Burn or Detonate  1

X - Coordinate of Explosion (ft)  5

Y - Coordinate of Explosion (ft)  5

Z - Coordinate of Explosion (ft)  5

Minimum Chamber Temp. Required to Initiate Explosive (deg R)  0

Minimum Time at Temperature to Initiate Explosive (sec)  0

Initial Weight of Energetic Material Burned (lbs)  0
(If ZERO, Initial Weight is set to Weight of Energetic Material/1000)

Does This Energetic Material Undergo Time Dependent Burning (Y/N)  N

F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 20: INPUT SCREEN 4,2 - PROBLEM 2

```
ENERGETIC SOURCE #2          INBLAST PROGRAM
                  (Input Screen 4,2 / EXPLOSIVE DATA cont.)

Weight of Energetic Material (lb)  200

Number of Chamber in Which Energetic Material will Burn or Detonate  2

X - Coordinate of Explosion (ft)  5

Y - Coordinate of Explosion (ft)  5

Z - Coordinate of Explosion (ft)  5

Minimum Chamber Temp. Required to Initiate Explosive (deg R)  0

Minimum Time at Temperature to Initiate Explosive (sec)  0

Initial Weight of Energetic Material Burned (lbs)  0
(If ZERO, Initial Weight is set to Weight of Energetic Material/1000)

Does This Energetic Material Undergo Time Dependent Burning (Y/N)  Y

F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 21: INPUT SCREEN 4,3 - PROBLEM 2

```
ENERGETIC SOURCE #3          INBLAST PROGRAM
                  (Input Screen 4,3 / EXPLOSIVE DATA cont.)

Weight of Energetic Material (lb)  150

Number of Chamber in Which Energetic Material will Burn or Detonate  8

X - Coordinate of Explosion (ft)  5

Y - Coordinate of Explosion (ft)  5

Z - Coordinate of Explosion (ft)  5

Minimum Chamber Temp. Required to Initiate Explosive (deg R)  0

Minimum Time at Temperature to Initiate Explosive (sec)  0

Initial Weight of Energetic Material Burned (lbs)  0
(If ZERO, Initial Weight is set to Weight of Energetic Material/1000)

Does This Energetic Material Undergo Time Dependent Burning (Y/N)  N

F1 SET TO     F2 GOTO NEXT   F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN         MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 22: INPUT SCREEN 4,4 - PROBLEM 2

```
ENERGETIC SOURCE #4          INBLAST PROGRAM
                  (Input Screen 4,4 / EXPLOSIVE DATA cont.)

Weight of Energetic Material (lb)  150

Number of Chamber in Which Energetic Material will Burn or Detonate  8

X - Coordinate of Explosion (ft)  5

Y - Coordinate of Explosion (ft)  5

Z - Coordinate of Explosion (ft)  5

Minimum Chamber Temp. Required to Initiate Explosive (deg R)  800

Minimum Time at Temperature to Initiate Explosive (sec)  .02

Initial Weight of Energetic Material Burned (lbs)  0
(If ZERO, Initial Weight is set to Weight of Energetic Material/1000)

Does This Energetic Material Undergo Time Dependent Burning (Y/N)  N

F1 SET TO     F2 GOTO NEXT   F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN         MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 23: INPUT SCREEN 5 - PROBLEM 2

```
ENERGETIC SOURCE #2          INBLAST PROGRAM
                    (Input Screen 5,2 / 1ST BURN TABLE)

                BURN AREA (sq in) vs. WEIGHT BURNED (lb) TABLE
Burn Area    Wt. Burned   Burn Area    Wt. Burned   Burn Area    Wt. Burned
100          0
100          200
0            200


F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 24: INPUT SCREEN 6 - PROBLEM 2

```
ENERGETIC SOURCE #2          INBLAST PROGRAM
                    (Input Screen 6,2 / 2ND BURN TABLE)

              BURN RATE x EXPLOSIVE DENSITY vs. PRESSURE TABLE

Burn Rate x                              Burn Rate x
Explosive Density      Pressure          Explosive Density      Pressure
(in/sec x lb/cu in)    (psia)            (in/sec x lb/cu in)    (psia)
100                    0
100                    1000


Note: Pressures must be in ascending order


F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 25: INPUT SCREEN 7 - PROBLEM 2

```
                    INBLAST PROGRAM
          (Input Screen 7 / AMBIENT CONDITIONS)

Default Pressure in Ambient Chamber (psia)  14.7
(If ZERO, the 1959 ARDC standard atmosphere is used)

Default Temperature in Ambient Chamber (deg C)  20

Altitude Above Sea Level (kft)  0

Default Initial Pressure in Chambers (psia)  0
(If ZERO, the Ambient Pressure will be used)

Default Initial Temperature in Chambers (deg C)  0
(If ZERO, the Ambient Temperature will be used)

Default Mole (volume) Fraction of Oxygen (O2) in Chambers  .2095
(Fraction must be > 0 and <= 1, Remainder is Nitrogen (N2))



F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 26: INPUT SCREEN 8 - PROBLEM 2

```
                    INBLAST PROGRAM
          (Input Screen 8 / CHAMBER DATA)

Chamber   Chamber      Length        Length        Length        Plot File
Number    Volume       X-Direction   Y-Direction   Z-Direction   (Y/N)
          (cu ft)      (ft)          (ft)          (ft)
Default   1000         10            10            10            N
9         -1           10            10            10            N



Note: If Chamber Volume = 0, volume is set to XLEN * YLEN * ZLEN
Note: Chamber Dimensions are not checked for compatibility with Chamber Volume
Note: An Ambient Chamber is Defined by Setting Volume < 0

F1 SET TO     F2 GOTO NEXT    F3 GOTO       NOTE: INDIVIDUAL DATA IS NOT SAVED
   DEFAULT       SCREEN          MAIN MENU        UNTIL RETURN KEY IS PRESSED
```

Figure 27: INPUT SCREEN 9 - PROBLEM 2

INBLAST PROGRAM
(Input Screen 9 / CHAMBER DATA (Cont.)

Chamber Number	Print Option	Type Of Calculation	Init. Pres. In Chamber (0 for Default) (psia)	Init. Temp. In Chamber (0 for Default) (deg C)	Mole Fraction Of Oxygen (0 for Default) (0 - 1)
Default	1	2	0	0	0
9	1	2	0	0	0

F1 SET TO DEFAULT F2 GOTO NEXT SCREEN F3 GOTO MAIN MENU NOTE: INDIVIDUAL DATA IS NOT SAVED UNTIL RETURN KEY IS PRESSED

Figure 28: INPUT SCREEN 10 - PROBLEM 2

INBLAST PROGRAM
(Input Screen 10 / VENTING DATA)

Number of Vent Paths Connecting Chambers (1 - 80) 10

Total Number of Venting Cycles (1 - 1000) 1000

Number of Venting Cycles Between Printouts (1 - 50) 50

Constant Time Step (sec) 0
(If ZERO, a variable venting time step will be used)

F1 SET TO DEFAULT F2 GOTO NEXT SCREEN F3 GOTO MAIN MENU NOTE: INDIVIDUAL DATA IS NOT SAVED UNTIL RETURN KEY IS PRESSED

FIGURE 30: INBLAST OUTPUT - PROBLEM 2

```
INTERNAL BLAST DAMAGE MECHANISMS PROGRAM, JULY 1989


  TEST5.....COMBUSTION and VENTING - multiple explosions in multiple chambers


 NOPT= 5     NEXPL=   4     NCHAMS=   9     NTARGS=   0     NTITLE=   1

 TMAX(SEC)=  .0000       ICALCG=  2     MAXORD=  10     RUN ID=                TEST5

 DEFINE EXPLOSIVE(S).....................................

  PENTOLITE (PETN/TNT,50/50)          4
 EXPLOSIVE (  1) PROPERTIES.....CHARGE WEIGHT(LB) =  200.0
 NUMBER EQWT  EFORM   EXPLOSIVE COMPOSITION BY WEIGHT
              KCAL/G    O2      N2      C       H2
    4  1.400 -.237100   .5155   .1807   .2798   .0239

  PENTOLITE (PETN/TNT,50/50)          4
 EXPLOSIVE (  2) PROPERTIES.....CHARGE WEIGHT(LB) =  200.0
 NUMBER EQWT  EFORM   EXPLOSIVE COMPOSITION BY WEIGHT
              KCAL/G    O2      N2      C       H2
    4  1.400 -.237100   .5155   .1807   .2798   .0239

 TIME-DEPENDENT BURNING OF EXPLOSIVE (  2)     INITIAL WEIGHT BURNED (WLB) =  .2000         INITIAL WT FRAC BURNED =  .0010

       3 POINTS IN BURN AREA VS WEIGHT BURNED TABLE
           A(SQ IN)       W(LB)          A(SQ IN)       W(LB)          A(SQ IN)       W(LB)          A(SQ IN)       W(LB)
             100.000        .000000        100.000        200.000        .000000        500.000

       2 POINTS IN BURN RATE VS PRESSURE TABLE
          R(LB/IN2/SEC)   P(PSIA)       R(LB/IN2/SEC)   P(PSIA)       R(LB/IN2/SEC)   P(PSIA)       R(LB/IN2/SEC)   P(PSIA)
             100.000        .000000        100.000        1000.00        100.000        1.000000E+07

  HMX                              30

 .....WEIGHT OF INERT MATERIAL IN THE EXPLOSIVE = 4.4999E-02 LBS. (WEIGHT FRACTION = .0003)
 EXPLOSIVE (  3) PROPERTIES.....CHARGE WEIGHT(LB) =  150.0
 NUMBER EQWT  EFORM   EXPLOSIVE COMPOSITION BY WEIGHT
              KCAL/G    O2      INERT   N2      C       H2
   30  1.100  .061000   .4322   .0003   .3782   .1621   .0272

  OCTOL                            31
 EXPLOSIVE (  4) PROPERTIES.....CHARGE WEIGHT(LB) =  150.0
 NUMBER EQWT  EFORM   EXPLOSIVE COMPOSITION BY WEIGHT
              KCAL/G    O2      N2      C       H2
```

31 1.100 .028620 .4302 .3303 .2135 .0260

.....EXPLOSIVE SUMMARY.....

EXPLOSIVE	CHAMBER	TIME DELAY(SEC)	BURN TEMP(DEG R)
1	1	.0000	.0000
2	2	.0000	.0000
3	8	.0000	.0000
4	8	2.0000E-02	800.0

PAMB(PSIA)= 14.70 TAMB(C)= 20.00 PCHAM(PSIA)= 14.70 TCHAM(C)= 20.00 FRAC O2= .2095

CHAMBER DATA.....NO. OF CHAMBERS = 9

K0	VOL(CU FT)	P(PSIA)	TEMP(C)	GAS(LB)	GAMMA	FRAC-O2	ICALC	IPRINT	IPLOT	X(FT)	Y(FT)	Z(FT)
1	1000.	14.70	20.00	74.90	1.3996	.2095	2	1	0	10.00	10.00	10.00
9	.0000	14.70	20.00	28.85	1.3996	.2095	2	1	0	10.00	10.00	10.00

VENTING DATA.....NO. OF VENTS = 10

IV	K1	K2	AREA(SQ FT)	PFAIL(PSIA)	TFAIL(SEC)
1	1	3	36.00	.0000	.0000
2	1	5	36.00	20.00	2.0000E-02
3	3	4	36.00	20.00	2.0000E-02
4	3	7	36.00	20.00	2.0000E-02
5	4	8	36.00	20.00	2.0000E-02
6	5	6	36.00	20.00	2.0000E-02
7	5	7	36.00	20.00	2.0000E-02
8	7	8	36.00	20.00	.0000
9	6	8	36.00	20.00	2.0000E-02
10	7	9	16.00	.0000	.0000

BEGIN VENTING CALCULATION.....

***** EXPLOSIVE (1) HAS BEEN ACTIVATED IN CHAMBER (1) AT TIME = .00000 SEC IN STEP 0 OF 1000 STEPS

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 1 AT TIME = .00000 SEC IN STEP 0 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	.0000	1000.	527.7	1.3996	74.90	.0000			
PERCENT LAST PRODUCT (CO2) = 10.757									
FINAL	700.3	1000.	6424.	1.2384	274.9	.0000	1.256	4.78074E+05	.00000

OVERPR = 704.7 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .6176

***** EXPLOSIVE (2) HAS BEEN ACTIVATED IN CHAMBER (2) AT TIME = .00000 SEC IN STEP 0 OF 1000 STEPS

***** EXPLOSIVE (3) HAS BEEN ACTIVATED IN CHAMBER (8) AT TIME = .00000 SEC IN STEP 0 OF 1000 STEPS

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 8 AT TIME = .00000 SEC IN STEP 0 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	.0000	1000.	527.7	1.3996	74.90	.0000			

PERCENT LAST PRODUCT (CO2) = 53.910

FINAL	645.9	1000.	7576.	1.2176	224.9	4.4999E-02	1.711	4.84698E+05	85.228

OVERPR = 649.2 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .5050

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 2 AT TIME = .00000 SEC IN STEP 0 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	.0000	1000.	527.7	1.3996	74.90	.0000			
OXIDATION COMPLETE									
FINAL	2.096	1000.	601.6	1.3977	75.10	.0000	2.656	7788.7	.00000

OVERPR = 2.125 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .1685

***** WALL (1) HAS FAILED BETWEEN CHAMBERS (1) AND (3) AT TIME = .00000 SEC IN STEP 0 OF 1000 STEPS

***** WALL (8) HAS FAILED BETWEEN CHAMBERS (8) AND (7) AT TIME = .00000 SEC IN STEP 0 OF 1000 STEPS

***** WALL (10) HAS FAILED BETWEEN CHAMBERS (7) AND (9) AT TIME = .00000 SEC IN STEP 0 OF 1000 STEPS

VENTING CALCULATION

TIME(SEC)	STEP OF NSTEPS	DT(SEC)	MAX PRESSURE DROP IN CHAMBER K0 =
.0000	0 1000	.0000	0

K0	OVERPR(PSI)	DPDT(PSI/SEC)	#V	AREA(SQ FT)	V(CU FT)	GASES(LB)	SOLIDS(LB)	TEMP(R)	GAMMA	EGAS(BTU)	ESOLID(BTU)
1	700.3	.0000	1	36.00	1000.	274.9	.0000	6424.	1.2384	4.78074E+05	.00000
2	2.096	.0000	0	.0000	1000.	75.10	.0000	601.6	1.3977	7788.7	.00000
3	.0000	.0000	1	36.00	1000.	74.90	.0000	527.7	1.3996	6813.5	.00000
7	.0000	.0000	2	52.00	1000.	74.90	.0000	527.7	1.3996	6813.5	.00000
8	645.9	.0000	1	36.00	1000.	224.9	4.4999E-02	7576.	1.2176	4.84698E+05	85.228
9	.0000	.0000	1	16.00	.0000	28.85	.0000	527.7	1.3996	2624.1	.00000

.....SUMMARY OF TIME-DEPENDENT BURNING OF EXPLOSIVES.....

EXPLOSIVE	CHAMBER	TOTAL WEIGHT	WEIGHT BURNED	FRACTION
2	2	200.00	.20000	.0010

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 3 AT TIME = 4.95395E-04 SEC IN STEP 50 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	75.20	1000.	2862.	1.2868	85.82	.0000			
OXIDATION COMPLETE									
FINAL	75.76	1000.	2881.	1.2862	85.82	.0000	.0000	50249.	.00000

OVERPR = 75.93 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .1926

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 7 AT TIME = 4.95395E-04 SEC IN STEP 50 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	54.07	1000.	2213.	1.3079	83.68	1.8780E-03			
OXIDATION COMPLETE									
FINAL	54.21	1000.	2218.	1.3077	83.68	1.8780E-03	.0000	35941.	1.0416

OVERPR = 54.34 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .1878

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 2 AT TIME = 4.95395E-04 SEC IN STEP 50 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	45.93	1000.	2062.	1.3094	79.95	.0000			
OXIDATION COMPLETE									
FINAL	46.73	1000.	2087.	1.3084	80.05	.0000	2.656	31945.	.00000

OVERPR = 46.84 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .1797

VENTING CALCULATION

TIME(SEC)	STEP OF NSTEPS	DT(SEC)	MAX PRESSURE DROP
4.9539E-04	50 1000	1.0175E-05	IN CHAMBER K0 = 1

K0	OVERPR(PSI)	DPDT(PSI/SEC)	#V	AREA(SQ FT)	V(CU FT)	GASES(LB)	SOLIDS(LB)	TEMP(R)	GAMMA	EGAS(BTU)	ESOLID(BTU)
1	666.1	-6.8912E+04	1	36.00	1000.	264.0	.0000	6371.	1.2386	4.54662E+05	.00000
2	46.73	.0000	0	.0000	1000.	80.05	.0000	2087.	1.3084	31945.	.00000
3	75.76	8.3086E+04	1	36.00	1000.	85.82	.0000	2881.	1.2862	50249.	.00000
7	54.21	9.1113E+04	2	52.00	1000.	83.68	1.8780E-03	2218.	1.3077	35941.	1.0416
8	613.1	-6.6003E+04	1	36.00	1000.	215.4	4.3112E-02	7515.	1.2178	4.60067E+05	81.002
9	.0000	.0000	1	16.00	.0000	28.85	.0000	527.7	1.3996	2624.1	.00000

.....SUMMARY OF TIME-DEPENDENT BURNING OF EXPLOSIVES.....

EXPLOSIVE	CHAMBER	TOTAL WEIGHT	WEIGHT BURNED	FRACTION
2	2	200.00	5.1539	.0258

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 3 AT TIME = 1.01908E-03 SEC IN STEP 100 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	136.6	1000.	4324.	1.2578	96.85	.0000			
OXIDATION COMPLETE									
FINAL	137.0	1000.	4339.	1.2575	96.85	.0000	.0000	93881.	.00000

OVERPR = 137.3 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .2174

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 7 AT TIME = 1.01908E-03 SEC IN STEP 100 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	98.67	1000.	3321.	1.2801	92.11	3.7442E-03			
OXIDATION COMPLETE									
FINAL	98.79	1000.	3325.	1.2800	92.11	3.7442E-03	.0000	64509.	3.1121

OVERPR = 99.03 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .2067

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 2 AT TIME = 1.01908E-03 SEC IN STEP 100 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	84.55	1000.	3201.	1.2763	85.18	.0000			
OXIDATION COMPLETE									
FINAL	85.30	1000.	3222.	1.2759	85.29	.0000	2.656	57481.	.00000

OVERPR = 85.49 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .1914

VENTING CALCULATION

TIME(SEC)	STEP OF NSTEPS	DT(SEC)	MAX PRESSURE DROP
1.0191E-03	100 1000	1.0771E-05	IN CHAMBER K0 = 1

K0	OVERPR(PSI)	DPDT(PSI/SEC)	#V	AREA(SQ FT)	V(CU FT)	GASES(LB)	SOLIDS(LB)	TEMP(R)	GAMMA	EGAS(BTU)	ESOLID(BTU)
1	632.0	-6.5192E+04	1	36.00	1000.	252.9	.0000	6315.	1.2388	4.31248E+05	.00000
2	85.30	.0000	0	.0000	1000.	85.29	.0000	3222.	1.2759	57481.	.00000
3	137.0	7.0374E+04	1	36.00	1000.	96.85	.0000	4339.	1.2575	93881.	.00000
7	98.79	7.6695E+04	2	52.00	1000.	92.11	3.7442E-03	3325.	1.2800	64509.	3.1121
8	580.3	-6.2314E+04	1	36.00	1000.	205.9	4.1211E-02	7452.	1.2180	4.35482E+05	76.777
9	.0000	.0000	1	16.00	.0000	28.85	.0000	527.7	1.3996	2624.1	.00000

.....SUMMARY OF TIME-DEPENDENT BURNING OF EXPLOSIVES.....

EXPLOSIVE	CHAMBER	TOTAL WEIGHT	WEIGHT BURNED	FRACTION
2	2	200.00	10.391	.0520

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 3 AT TIME = 1.57436E-03 SEC IN STEP 150 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	192.6	1000.	5373.	1.2416	108.0	.0000			
OXIDATION COMPLETE									
FINAL	193.0	1000.	5386.	1.2413	108.0	.0000	.0000	1.37724E+05	.00000

OVERPR = 193.5 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .2424

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 7 AT TIME = 1.57436E-03 SEC IN STEP 150 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	139.0	1000.	4142.	1.2654	100.2	5.5905E-03			
OXIDATION COMPLETE									
FINAL	139.1	1000.	4145.	1.2653	100.2	5.5905E-03	.0000	92371.	5.7932

OVERPR = 139.4 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .2250

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 2 AT TIME = 1.57436E-03 SEC IN STEP 150 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	121.2	1000.	4158.	1.2571	90.73	.0000			
OXIDATION COMPLETE									
FINAL	122.0	1000.	4176.	1.2568	90.84	.0000	2.656	84558.	.00000

OVERPR = 122.3 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .2039

VENTING CALCULATION

TIME(SEC)	STEP OF NSTEPS	DT(SEC)	MAX PRESSURE DROP
1.5744E-03	150 1000	1.1439E-05	IN CHAMBER K0 = 1

K0	OVERPR(PSI)	DPDT(PSI/SEC)	#V	AREA(SQ FT)	V(CU FT)	GASES(LB)	SOLIDS(LB)	TEMP(R)	GAMMA	EGAS(BTU)	ESOLID(BTU)
1	597.8	-6.1482E+04	1	36.00	1000.	241.8	.0000	6257.	1.2391	4.07834E+05	.00000
2	122.0	.0000	0	.0000	1000.	90.84	.0000	4176.	1.2568	84558.	.00000
3	193.0	6.1818E+04	1	36.00	1000.	108.0	.0000	5386.	1.2413	1.37724E+05	.00000
7	139.1	6.5974E+04	2	52.00	1000.	100.2	5.5905E-03	4145.	1.2653	92371.	5.7932

8	547.6	-5.8643E+04	1	36.00	1000.	196.4	3.9295E-02	7386.	1.2182	4.10945E+05	72.556
9	.0000	.0000	1	16.00	.0000	28.85	.0000	527.7	1.3996	2624.1	.00000

.....SUMMARY OF TIME-DEPENDENT BURNING OF EXPLOSIVES.....

EXPLOSIVE	CHAMBER	TOTAL WEIGHT	WEIGHT BURNED	FRACTION
2	2	200.00	15.944	.0797

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 3 AT TIME = 2.16511E-03 SEC IN STEP 200 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	245.7	1000.	6166.	1.2306	119.3	.0000			
OXIDATION COMPLETE									
FINAL	246.1	1000.	6177.	1.2304	119.3	.0000	.0000	1.81791E+05	.00000

OVERPR = 246.8 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .2677

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 7 AT TIME = 2.16511E-03 SEC IN STEP 200 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	176.3	1000.	4777.	1.2554	108.1	7.4103E-03			
OXIDATION COMPLETE									
FINAL	176.4	1000.	4780.	1.2553	108.1	7.4103E-03	.0000	1.19409E+05	8.8563

OVERPR = 176.8 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .2426

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 2 AT TIME = 2.16511E-03 SEC IN STEP 200 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	157.3	1000.	4986.	1.2431	96.63	.0000			
OXIDATION COMPLETE									
FINAL	158.0	1000.	5001.	1.2428	96.75	.0000	2.656	1.13364E+05	.00000

OVERPR = 158.4 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .2171

(693 lines removed)

VENTING CALCULATION

TIME(SEC)	STEP OF NSTEPS	DT(SEC)	MAX PRESSURE DROP
5.2596E-02	921 1000	3.0677E-04	IN CHAMBER K0 = 3

K0	OVERPR(PSI)	DPDT(PSI/SEC)	#V	AREA(SQ FT)	V(CU FT)	GASES(LB)	SOLIDS(LB)	TEMP(R)	GAMMA	EGAS(BTU)	ESOLID(BTU)
1	257.8	2074.	2	72.00	1000.	123.1	2.1293E-05	5490.	1.2424	1.77966E+05	2.92231E-02
2	695.0	.0000	0	.0000	1000.	269.3	5.584	6676.	1.2276	4.96169E+05	15900.
3	255.9	-1.0544E+04	3	108.0	1000.	111.3	2.5842E-04	6782.	1.2194	1.97787E+05	.43814
4	258.3	-2659.	2	72.00	1000.	119.5	2.8567E-03	6336.	1.2294	1.90835E+05	4.5250
5	255.9	-9774.	2	72.00	1000.	117.2	2.4719E-03	6522.	1.2223	1.95184E+05	4.0307
6	258.5	-35.26	1	36.00	1000.	116.3	4.1236E-03	6476.	1.2263	1.93390E+05	6.6755
7	255.3	1.6354E+04	4	124.0	1000.	107.7	6.5756E-03	6712.	1.2220	1.94149E+05	11.033
8	256.4	-6941.	3	108.0	1000.	109.5	1.668	6130.	1.2301	1.86059E+05	4276.9
9	.0000	.0000	1	16.00	.0000	28.85	.0000	527.7	1.3996	2624.1	.00000

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 4 AT TIME = 9.23196E-02 SEC IN STEP 971 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	205.3	1000.	6152.	1.2294	99.14	3.5092E-03			
OXIDATION COMPLETE									
FINAL	205.6	1000.	6163.	1.2293	99.14	2.4281E-03	.0000	1.53780E+05	3.7414

OVERPR = 206.0 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .2225

COMBUSTION OF EXPLOSIVE PRODUCTS IN CHAMBER 6 AT TIME = 9.23196E-02 SEC IN STEP 971 OF 1000 STEPS

	OVERPR(PSI)	V(CU FT)	TEMP(DEG R)	GAMMA	GASES(LB)	SOLIDS(LB)	E RELEASED(KCAL/GM)	EGAS(BTU)	ESOL(BTU)
INITIAL	206.4	1000.	6274.	1.2267	97.16	3.7136E-03			
OXIDATION COMPLETE									
FINAL	206.5	1000.	6276.	1.2267	97.16	3.4708E-03	.0000	1.55995E+05	5.4453

OVERPR = 207.0 USING A REAL GAS APPROX.....PERCENT DIFFERENCE FROM PERFECT GAS = .2181

VENTING CALCULATION

TIME(SEC)	STEP OF NSTEPS	DT(SEC)	MAX PRESSURE DROP
9.2320E-02	971 1000	5.4213E-04	IN CHAMBER K0 = 3

K0	OVERPR(PSI)	DPDT(PSI/SEC)	#V	AREA(SQ FT)	V(CU FT)	GASES(LB)	SOLIDS(LB)	TEMP(R)	GAMMA	EGAS(BTU)	ESOLID(BTU)
1	205.9	-819.2	2	72.00	1000.	103.0	5.1683E-05	5325.	1.2428	1.43635E+05	6.87971E-02
2	695.0	.0000	0	.0000	1000.	269.3	5.584	6676.	1.2276	4.96169E+05	15900.
3	204.6	-1.2829E+04	3	108.0	1000.	93.33	4.7162E-04	6520.	1.2208	1.58850E+05	.76873
4	205.6	5395.	2	72.00	1000.	99.14	2.4281E-03	6163.	1.2293	1.53780E+05	3.7414
5	203.3	-4981.	2	72.00	1000.	93.25	1.7322E-03	6637.	1.2165	1.61221E+05	2.8743
6	206.5	483.1	1	36.00	1000.	97.16	3.4708E-03	6276.	1.2267	1.55995E+05	5.4453
7	200.4	1.3941E+04	4	124.0	1000.	90.38	9.5517E-02	6392.	1.2234	1.53361E+05	254.06
8	204.2	-1.0100E+04	3	108.0	1000.	91.45	.4117	6074.	1.2304	1.50448E+05	1039.8
9	.0000	.0000	1	16.00	.0000	28.85	.0000	527.7	1.3996	2624.1	.00000

VENTING CALCULATION

TIME(SEC)	STEP OF NSTEPS	DT(SEC)	MAX PRESSURE DROP
.2201	1000 1000	3.2068E-02	IN CHAMBER K0 = 6

K0	OVERPR(PSI)	DPDT(PSI/SEC)	#V	AREA(SQ FT)	V(CU FT)	GASES(LB)	SOLIDS(LB)	TEMP(R)	GAMMA	EGAS(BTU)	ESOLID(BTU)
1	142.1	274.9	2	72.00	1000.	77.25	9.1658E-05	5079.	1.2434	1.01674E+05	.11830
2	695.0	.0000	0	.0000	1000.	269.3	5.584	6676.	1.2276	4.96169E+05	15900.
3	138.5	-1883.	3	108.0	1000.	68.99	5.6310E-04	6135.	1.2225	1.09671E+05	.86374
4	140.8	-706.7	2	72.00	1000.	73.72	1.8201E-03	5857.	1.2298	1.07989E+05	2.6649
5	137.0	-1618.	2	72.00	1000.	69.97	1.1077E-03	5964.	1.2236	1.07877E+05	1.7454
6	140.7	-2324.	1	36.00	1000.	72.14	2.5958E-03	5941.	1.2276	1.08814E+05	3.8557
7	115.8	-210.5	4	124.0	1000.	59.10	1.4311E-02	5968.	1.2251	92090.	33.860
8	146.2	954.1	3	108.0	1000.	70.01	3.5644E-03	6076.	1.2264	1.12788E+05	5.4138
9	.0000	.0000	1	16.00	.0000	28.85	.0000	527.7	1.3996	2624.1	.00000